88 Rec'd PCT/PTO 29 APR 1998

FORM PTO-1390 (REV 5-93) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 15258-317

U.S. APPLICATION NO. (If known, see 37 C.F.R 1.5): 09/066383

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/IB96/01156	October 28, 1996	October 31, 1995

TITLE OF INVENTION
FLUID-FLUID CONTACTING APPARATUS

APPLICANT(S) FOR DO/EO/US
WILLIAM DAVID PARTEN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   - b. ☒ has been transmitted by the International Bureau.
   - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   - b. ☐ have been transmitted by the International Bureau.
   - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98. (7 references)
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
    4 sheets formal drawings
    International Search Report
    International Preliminary Examination Report

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.50)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
	PCT/IB96/01156	15258-317

17. [x] The following fees are submitted:

		CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO .... $910.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) .... $700.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)).. $770.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37CFR 1.445(a)(2)) paid to USPTO......... $1,040.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)........... $96.00			
ENTER APPROPRIATE BASIC FEE AMOUNT =		$ 930	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	14 -20 =		X $22.00	$	
Independent Claims	2 -3 =		X $80.00	$	
Multiple dependent claims(s) (if applicable)			+ $260.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 930	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later the [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 930	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$930	
				Amount to be: refunded	$
				charged	$ 930

a. [ ] A check in the amount of $______ to cover the above fees is enclosed.

b. [x] Please charge my Deposit Account No. 20-1430 in the amount of $ 930 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [x] The Commissioner is hereby authorized to charge any additional fees associated with this paper or during the pendency of this application, or credit any overpayment to the Deposit Account No. 20-1430. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
J. Georg Seka
Townsend and Townsend and Crew LLP
Two Embarcadero Center, 8th Fl.
San Francisco, CA 94111

Kevin T. LeMond (signature)
SIGNATURE

Kevin T. LeMond
NAME

35,933
REGISTRATION NUMBER

09/066383

88 Rec'd PCT/PTO 29 APR 1998

Attorney Docket No.: 15258-317 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. National Phase of PCT/IB96/01156 of WILLIAM DAVID PARTEN Serial No: not yet assigned Filed: herewith For: FLUID-FLUID CONTACTING APPARATUS	PRELIMINARY AMENDMENT

San Francisco, CA 94111
April 29, 1998

Box PCT
Assistant Commissioner of Patents
Washington, D.C. 20231

Sir:

Please make the following amendments to this application.

IN THE CLAIMS:

Claim 5, line 1, please delete "or 4".

Claim 6, line 1, delete "any one of Claims 1 to 5" and substitute therefor --Claim 1--.

Claim 8, line 1, delete "any one of Claims 1 to 7" and substitute therefor --Claim 1--.

WILLIAM DAVID PARTEN
Serial No.: not yet assigned

REMARKS

Amendment is made to eliminate all multiple dependencies in the claims, thereby avoiding the need to pay the multiple dependent surcharge.

Respectfully submitted,

Kevin T. LeMond
Reg. No. 35,933

KTL/tp
15258-317.pre

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P.6765

Sulzer Chemtech AG, Winterthur, Schweiz

FLUID-FLUID CONTACTING APPARATUS

This invention relates to fluid-fluid contacting apparatus and, in particular, to structured packings for use in such apparatus. Typically apparatus of the type that the invention relates to is used for operations such as distillation, absorption, scrubbing, stripping, heat exchange etc in which one fluid (eg a liquid) is brought into contact with another fluid (eg a gas) with the fluids usually flowing countercurrent relative to each other. In the case of gas (or vapour)/liquid contacting, the gas constitutes the continuous phase.

The invention is especially concerned with fluid-fluid contacting apparatus in which the structured packing comprises a number of packing elements arranged in succession in the direction of fluid flow through the apparatus which is usually in the form of a vertically disposed column or tower. Each packing element comprises a plurality of crimped sheets of material arranged in face to face relationship with rectilinear corrugations extending obliquely relative to the direction of fluid flow and successive elements are arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s). Vendors of commercially available packings of this type recommend angular displacements of 90° (Sulzer Brothers Limited) and 70° (Norton Chemical Company).

In their range of packings, one supplier (Sulzer) produces an 'X' range of packings and a 'Y' range of packings. The sheet materials used in the two forms of packings are believed to be identical with respect to surface area and surface treatment but differ by the angle of crimp. In the 'Y' series of packings, the crimp angle is 45° to the horizontal whereas the 'X' series have a crimp angle at 60° to the horizontal.

The 'Y' series packing elements have a higher efficiency but lower capacity than the 'X' series packing elements. The efficiency of a structured packing is a property of the way vapour and liquid contact each other over the whole surface of the packing. The capacity of the packing is set by the capacity at its most restricted elevation. The 'X' series packing elements impose a smaller change in direction on the fluids at the interface due to the larger angle subtended to the horizontal by the crimp angle and therefore have a larger capacity than the equivalent 'Y' series packing elements. The pressure drop within the 'Y' series packing elements is greater and the use of the surface area for mass transfer is greater, hence the 'Y' series packing elements have a higher efficiency.

Recent indications suggest that the capacity of a structured packing is governed by the behaviour of the fluids at the interface between successive packing elements. For instance, where liquid-vapour contact is involved, the pressure drop in the vapour phase is higher at the interface between successive packing elements where the liquid and vapour are forced to move through a change in direction, than in the body of each packing element and, as a result, liquid tends to build up at the interface. The build up of liquid occurs over a greater range of the operating conditions the higher the liquid load. It is therefore assumed that the widely recognised affect of loss of performance in structured packing at higher pressure is due to a build up of liquid at the interfaces between successive packing elements leading to maldistribution of the liquid into the next packing element in the direction of liquid flow.

According to one aspect of the present invention there is provided fluid-fluid contacting apparatus in which the structured packing comprises a number of packing elements arranged in succession in the designed direction of fluid flow, each packing element comprising a plurality of crimped sheets of material arranged in face to face relationship with the corrugations extending obliquely relative to the direction of fluid flow, successive elements being arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s), characterised by the provision of means at or in the vicinity of the interface between successive elements for reducing the pressure drop imposed on the continuous phase at the interface.

In this manner, it is possible to secure good efficiency without unduly sacrificing capacity (and vice versa). Said means may have the effect of generally smoothing the rate of change of pressure throughout the packed section of the apparutus without necessarily reducing the overall pressure drop across the packed section (although such overall pressure drop may occur). In particular, said means serves to reduce the rate of change of pressure at and in the immediate vicinity of said interfaces.

Such means may be implemented by configuring the corrugations in the sheets so as to secure reduced pressure drop.

In one embodiment , instead of employing rectilinear corrugations, at least some (preferably the majority if not all) of the sheets of each packing element have at least some (preferably the majority if not all) corrugations whose angle of obliquity varies between opposite faces of the packing element such that the angle of obliquity is greater in the vicinity of at least one (preferably both) of said faces than the greatest angle of obliquity within the body of the packing element.

By "angle of obliquity" at a particular point along the length of a corrugation, we mean the angle between the axis of the corrugation at that point and a plane containing said point and parallel to said opposite faces.

Thus, in a typical implementation of this embodiment, each sheet of a packing element may be provided with corrugations which impart a change in flow direction as fluid flows through the body of the packing element from one face to the opposite face, the corrugations having a terminal portion or portions (depending on whether the particular corrugation extends to one or both of said opposite faces) which intersect said faces at an angle of up to 90° while the intermediate portions of each corrugation over at least part of the length thereof extend at an angle somewhat less, eg typically less than 60°.

The angle of obliquity of each such corrugation preferably changes progressively in the lengthwise direction although we do not exclude the possibility of the change being of a discontinuous nature.

By imparting a variable angle of obliquity to the sheets of the packing elements, mass transfer within the heart of each packing element can be maximised and the use of a higher angle of obliquity in the vicinity of the packing element avoids an extreme change in direction as the fluids pass from one packing element to the next.

In another embodiment of the invention, said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface may be implemented by producing at least some (preferably the majority if not all) of the corrugations in at least some (preferably the majority if not all) of the sheets of each packing element with a reduced cross-section in the vicinity of a least one (preferably both) of the faces of the packing element thereby reducing the surface area and pressure drop at such location.

The localised reduction in cross-sectional area of the corrugations may be effected by a reduction in depth. The reduction in depth is preferably progressive as the corrugations approach the end faces of the packing elements.

If desired, such localised reduction in the cross-sectional area of the corrugations may be combined with variation in the angle of obliquity as described above or the reduction may be employed with corrugations which are otherwise of conventional configuration. The reduction in cross-sectional area or depth may take place progressively and may be to such an extent that the corrugations terminate short of the edges proper of the sheets, ie so that marginal edges of the sheets are flat (non-corrugated). Because a reduction in depth will result in the sheets being out of contact with one another, if desired or necessary means may be provided for supporting the sheets in spaced relation with each other and/or increasing the rigidity of the structure in the regions where the depth of the corrugations is reduced. Such means may comprise spacer elements extending between adjacent sheets or the sheets may be provided with formations along those edges which border the interfaces between adjacent packing elements, which formations may be designed to co-operate (eg interdigitate) at the interface to maintain sheet spacing and/or enhance rigidity.

In yet another embodiment of the invention, said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface may be implemented by provision of fluid flow control means between successive packing elements whereby the localised direction of flow of fluid leaving one packing element is rendered more compatible with the next packing element so as to reduce the pressure drop.

In this instance, the successive packing elements are spaced apart from one another in the direction of bulk fluid flow through the apparatus and the fluid flow control means is located in the gap. Such control means may comprise an open structure having a series of walls which extend between successive packing elements and which may for instance be generally parallel with one another and/or be arranged in two sets with one set of walls intersecting the other. Thus, for example, the control means may comprise an open grid structure having cells through which fluid exiting one packing element passes before entering the next packing element, the cells having axes which are substantially parallel to the direction of bulk flow of fluid through the apparatus or at least more closely in parallelism with direction of said bulk flow than said corrugations. Alternatively the control means may comprise an arrangement of regularly or irregularly shaped objects, such as Raschig and/or Pall rings, preferably oriented with the major part of their surface areas extending predominantly in the direction of said direction of bulk flow so that the fluid passing from one packing element to the next has a flow direction which is predominantly parallel with said direction of bulk flow.

In a further embodiment of the invention, said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface may be implemented by provision of a gap between successive packing elements. In this embodiment, the packing elements may be supported in spaced relation with a gap therebetween sufficient to secure a significant reduction in the pressure drop imposed on the continuous phase as it passes from one packing element to the next. Preferably the gap, ie the perpendicular distance between planes containing the extremities of successive packing elements at each interface, is at least 2 cm, more usually at least 4 cm. Where the packing elements are separated from one another in this way, without any intervening structure such as a support grid between them, it may be desirable to control the descending liquid phase so as to promote efficient transfer from one packing element to the packing element below otherwise there may be a tendency for the liquid phase to run along the sheet edges at the interface with the possibility of maldistribution. For instance, the sheet edges at the lower faces of the packing elements may be contoured to promote collection of the liquid at well-defined sites so that the liquid phase then drips from these sites on to the packing element below. Thus, for example, the sheet edges at the lower faces may have a zigzag configuration so that the liquid phase collects, and drips, from the apices. It will be appreciated that the zigzag configuration will be such that a large number of drip sites are distributed substantially uniformly across the interface.

The materials of fabrication of the sheets may be selected from those usually employed in structured packing, eg thin foil-like materials (metal or otherwise), gauze materials, etc. The sheets may be perforated to allow passage of fluid from one side of the sheet to the other as the fluids flow through the packing.

The surface of the sheet material may be smooth or it may be textured by any appropriate technique to improve its wetting, liquid distribution and cross-mixing properties for example.

The profile of the corrugations in cross-section may take various forms commonly used in structured packings, eg semi-circular, V-shaped etc. Likewise, the dimensions of the corrugations may be generally the same as used in commercially available structured packing such as sold by Sulzer and Norton Chemical Company. The corrugations need not necessarily be continuous throughout the packing element. For instance, as used in a commercially available structured packing, the corrugations may be interrupted within the body of the packing element for example in such a way that a first series of corrugations extend part-way through the element and a second series of corrugations then succeed said first series and extend through the remainder of the element, the peaks and troughs of the first series being laterally offset relative to those of the second series and apertures being formed in the sheets at the junctions between the two series whereby fluids can pass from one side of the sheet to the other.

Mass transfer at the interfaces may be reduced at the interfaces between packing elements in accordance with the present invention. Consequently the depth dimension (as considered in the direction of bulk flow through the apparatus) of a packing element in accordance with the invention when optimised with respect to efficiency may differ from that of (and typically be greater than) a conventional structured packing element having the same efficiency.

The invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a digrammatic view of a packed column;

Figure 2 is a fragmentary view of a packing element schematically showing the configuration of the corrugations in adjacent sheets;

Figure 3 is a fragmentary view showing (a) the corrugation profil at a location inwardly removed from the interface between adjacent packing elements, and (b) the corrugation profil at a location immediately adjacent the interface;

Figure 4 is a fragmentary view showing an alternative embodiment;

Figure 5 is a fragmentary view showing an embodiment corresponding to the embodiment of Figure 3; and

Figure 6 is a fragmentary view showing an embodiment corresponding to the embodiment of Figure 4.

Referring to Figure 1, the invention will be decribed with reference to a packed column or tower 10 for use in for example mass transfer or heat exchange between a descending liquid phase and an ascending vapour phase. At its upper end, the column 10 is provided a liquid distributor 12 and a vapour outlet 14. At its lower end, the column is provided with a vapour inlet 16 and a liquid outlet 18. A number of structured packing elements 20 stacked vertically above a support 22. Each packing element comprises a series of parallel sheets or lamellae arranged in planes extending substantially vertically with the sheets in each packing element disposed at an angle to those in the adjacent packing element(s). This angle may be 90° for instance but other angles are possible. The packing elements are fabricated so that they extend across substantially the full width of the column and are of a convenient depth for installation, typically 30 cm deep. Each packing element in the embodiment of Figure 1 is located in abutting relation with its neighbours with interfaces 21 between them.

Referring to Figure 2, each sheet or lamella 24 is formed with a series of corrugations 26 with peaks or crests 28 extending generally obliquely between the upper and lower faces of the respective packing element and adjacent sheets are oriented with the corrugations thereof intersecting in criss-cross fashion. Adjacent sheets contact each other at the points of intersection between the peaks of one sheet and those of the neighbouring sheets. In contrast with commercially available structured packings, the corrugations are not rectilinear along their entire length - instead each corrugation 26 has a terminal portion or portions 30, 32 (depending on whether it extends to just one or both of the upper and lower faces of the packing element) disposed at a different angle to the intermediate portion of the corrugation. As shown the corrugations 26 change direction progressively between the upper and lower faces of the packing elements such that the terminal portions 30, 32 have axes which are substantially perpendicular to those faces while the intermediate portions are inclined to the vertical. In Figure 2, the solid lines depict the peaks 28 of the corrugations in the face of the sheet presented to the viewer while the broken outlines 28' depict the peaks of the corrugations in the corresponding face of the sheet immediately behind the one in view. Although in Figure 2, the terminal portions 30, 32 of the corrugations intersect the upper and lower faces substantially perpendicularly, it will be understood that the advantages of the invention may still be secured even if the angle of intersection is less than 90°.

Referring to Figure 3, in this embodiment the corrugations may be oriented generally as shown in Figure 2 or they may be of the rectilinear configuration used in commercially available structured packing such as the 'X' or 'Y' series packing elements manufactured and sold by Sulzer Brothers Limited. Reduced pressure drop is secured or enhanced in this case by reducing the depth of the corrugations in the vicinity of the interfaces 21 of the packing elements (see Figure 1). Thus, the profile shown at (a) in Figure 3 represents the corrugation shape at locations inwardly removed from the interfaces 21 of the packing element while the profile shown at (b) represents a reduced depth corrugation shape at or immediately adjacent the interfaces 21. It will be understood that the reduction in depth will mean that the adjacent sheets will no longer have

peak to peak contact with one another in these regions. If necessary, spacers or the like (not shown) may be provided to maintain uniform spacing between the sheets and/or enhance rigidity of the structure where peak to peak contact does not exist.

In the embodiment of Figure 1, the structured packing elements 20 are vertically stacked in abutting face to face relation. However, as indicated in Figure 4, the packing elements 20 (which may comprise commercially available elements such as those described previously) are arranged in vertically spaced relation to reduce pressure drop between successive packing elements, fluid control means 40 are located between successive packing elements in order to render the fluid flow from one packing element more compatible with the orientation of the next packing element. The fluid control means may as shown be in the form of an open grid structure with the cells of the grid having walls whose surfaces lie in substantially vertically extending planes so that liquid and vapour exiting one packing element at an angle imposed by the obliquely extending corrugations is constrained to pass through the grid structure before entering the next packing element. In this way, the angle of exit flow is modified so as to be substantially vertical before the liquid and vapour enters the differently orientated corrugations of the next packing element. Although not shown in this way, the corrugations in the packing elements and the grids may be so arranged that the cells in the grids effectively form continuations of the corrugations and serve to smoothly deflect flow of the continuous phase from one packing element towards a flow direction corresponding to the orientation of the corrugations in the next packing element.

Although the invention is described with reference to vapour-liquid contacting, we do not exclude the possibility of other forms of fluid-fluid contact, particularly liquid-liquid contact where one liquid, usually the less dense liquid, forms the continuous phase.

Corresponding to Figure 3, Figure 5 shows an embodiment with rectilinear corrugations 26 and terminal portions 32 adjacent the interface 21 with reduced depth corrugation shape. The depth of the corrugations 26 is a, the reduced depth at the interface 21 is b. At any height of the terminal portions 32, the total length of the crimped sheet (i e the length of unwinding of any horizontal intersection line) is equal to the corresponding length of the corrugations 26.

Corresponding to Figure 4, Figure 6 shows an embodiment with fluid control means 40 located between successive packing elements 20 in form of a grid. The square-shaped cells form a continuation of the corrugations.

CLAIMS

1. Fluid-fluid contacting apparatus in which the structured packing comprises a number of packing elements arranged in succession in the designed direction of fluid flow, each packing element comprising a plurality of crimped sheets of material arranged in face to face relationship with the corrugations extending obliquely relative to the direction of fluid flow, successive elements being arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s), characterised by the provision of means at or in the vicinity of the interface between successive elements for reducing the pressure drop imposed on the continuous phase at the interface.

2. Apparatus as claimed in Claim 1 in which said means is constituted by a localised change in the configuration of the corrugations immediately adjacent the interfaces.

3. Apparatus as claimed in Claim 2 in which at least some of the sheets of each packing element have at least some corrugations whose angle of obliquity varies between opposite faces of the packing element such that the angle of obliquity is greater in the vicinity of at least one of said faces than the greatest angle of obliquity within the body of the packing element.

4. Apparatus as claimed in Claim 3 in which the corrugations have a terminal portion or portions which intersect said faces at an angle of up to 90° while the intermediate portions of each corrugation over at least part of the length thereof extend at an angle somewhat less.

5. Apparatus as claimed in Claim 3 or 4 in which the angle of obliquity of each such corrugation changes progressively in the lengthwise direction.

6. Apparatus as claimed in any one of Claims 1 to 5 in which at least some of the corrugations in at least some of the sheets of each packing element are formed with a reduced cross-section in the vicinity of a least one of the faces of the packing element thereby reducing the surface area and pressure drop at such location.

7. Apparatus as claimed in Claim 6 in which at least some of the corrugations have a localised reduction in depth in the vicinity of a least one of the faces of the packing element.

8. Apparatus as claimed in any one of Claims 1 to 7 in which said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface comprises fluid flow control means.

9. Apparatus as claimed in Claim 8 in which the successive packing elements are spaced apart from one another in the direction of bulk fluid flow through the apparatus and said fluid flow control means is located in the gap.

10. Apparatus as claimed in Claim 1 in which said means at or in the vicinity of the interface between successive elements for reducing pressure drop at the interface comprises a gap effective to produce a significant reduction in the pressure drop imposed on the continuous phase at the interface.

11. Apparatus as claimed in Claim 10 in which said gap is at least 2 cm.

12. A structured packing element comprising a plurality of crimped sheets of material arranged in face to face relationship with the corrugations extending obliquely relative to the direction of fluid flow, successive elements being arranged with the sheets in one element angularly displaced with respect to the sheets of the adjacent element(s), the corrugations having a localised change in the configuration of the corrugations immediately adjacent at least one face of the element whereby, when two such elements are located face to face, the localised change in configuration is effective to reduce the pressure drop imposed on the continuous phase at the interface.

13. An element as claimed in Claim 10 in which said localised change in configuration comprises a change in the angle of obliquity in the vicinity of at least one of the faces of the element such that the angle of obliquity is greater at such location than at locations inwardly removed from said one face.

14. An element as claimed in Claim 10 in which said localised change in configuration comprises a reduction in the depth of the corrugations in the vicinity of at least one of the faces of the element.

ABSTRACT

FLUID-FLUID CONTACTING APPARATUS

Fluid-fluid contacting apparatus is provided with a structured packing comprising a series of packing elements fabricated from sheets of crimped material in such a way that the corrugations in each sheet extend obliquely with respect to the direction of bulk fluid flow through the apparatus. Each packing element is oriented with the sheets thereof in a plane which is angularly displaced with respect to the sheets of neighbouring elements. Means is provided at or in the vicinity of the interface between neighbouring elements for reducing the pressure drop imposed on the continuous phase as it passes from one element to the next.

APPROVED BY DRAFTSMAN	O.G. FIG.	
	CLASS	SUBCLASS

09/066383

Fig.1

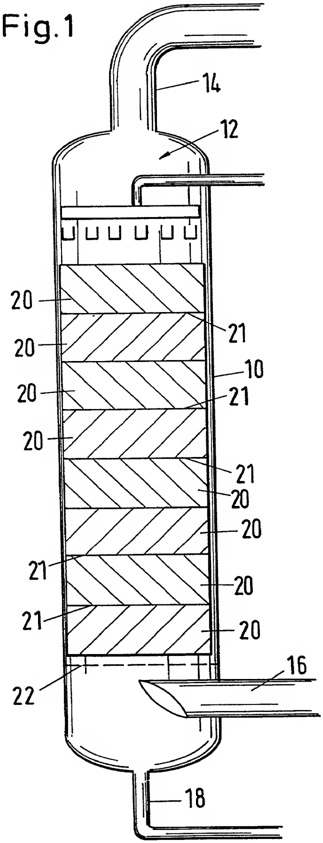


Fig. 4

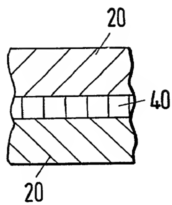


Fig. 2

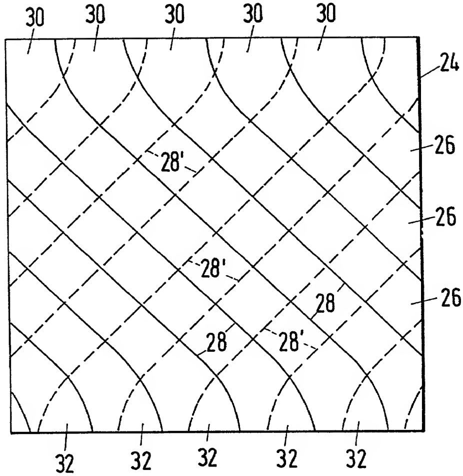
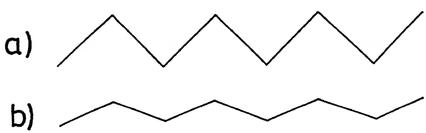


Fig. 3



APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

09/066383

Fig. 5

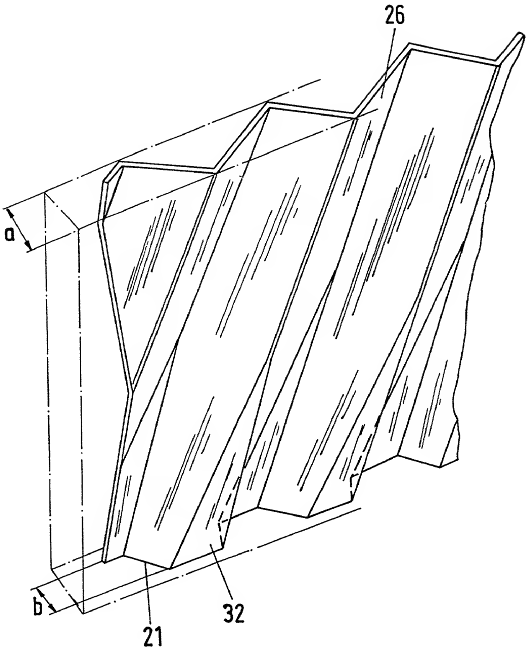
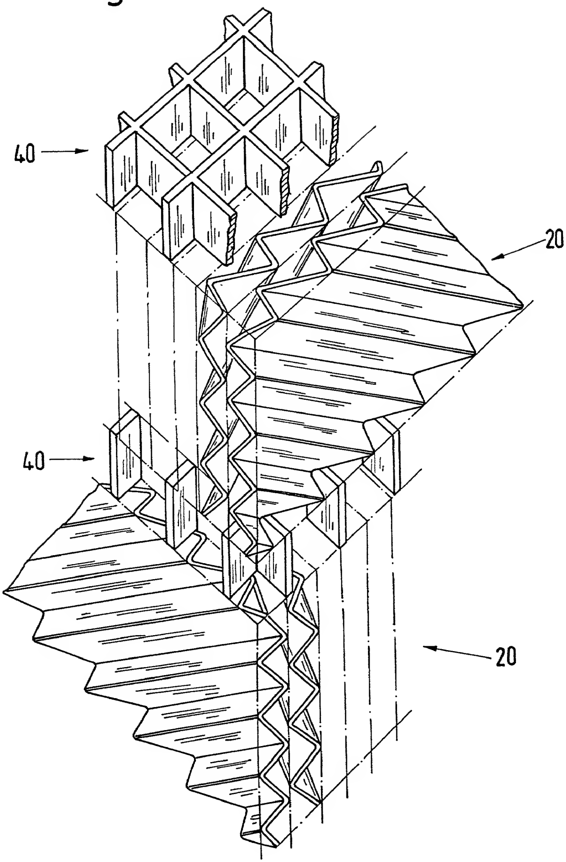


Fig. 6



COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
(Includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER P.67863 US

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

FLUID-FLUID CONTACTING APPARATUS

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No. ______

on ______,

and was amended

on ______ (if applicable).

☒ was filed as PCT international application

Number PCT/IB96/01156

on October 28, 1996,

and was amended under PCT Article 19

on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Great Britain (GB)	9522086.9	October 31, 1995	☒ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

Combined Declaration For Patent Application and Power of Attorney (Continued)
(Includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

(4)
J. Georg Seka; Reg. No. 24,491 Kevin T. LeMond , Reg. No. 35,933
James F. Hann; Reg. No. 29,791
Charles E. Krueger; Reg. No. 30,077

Send Correspondence to: J. Georg Seka
Townsend and Townsend and Crew
Two Embarcadero Center, 8th Fl.
San Francisco, CA 94111-3834

Direct Telephone Calls to: (name and telephone number)
J. Georg Seka
415-576-0200

201	FULL NAME OF INVENTOR 1-00	FAMILY NAME PARTEN	FIRST GIVEN NAME William	SECOND GIVEN NAME David
	RESIDENCE & CITIZENSHIP	CITY Middlesbrough	STATE OR FOREIGN COUNTRY Great Britain	COUNTRY OF CITIZENSHIP Great Britain GB
	POST OFFICE ADDRESS	POST OFFICE ADDRESS Northolme, Tame Bridge Stokgsley	CITY Middlesbrough	STATE & ZIP CODE/COUNTRY TS9 5LQ GB
202	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
203	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201 William David Parten	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE 14th JAN. 1998	DATE	DATE

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